Thermal Testing Facilities & Efforts at Dryden Flight Research Center

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Thermal & Fluids Analysis Workshop
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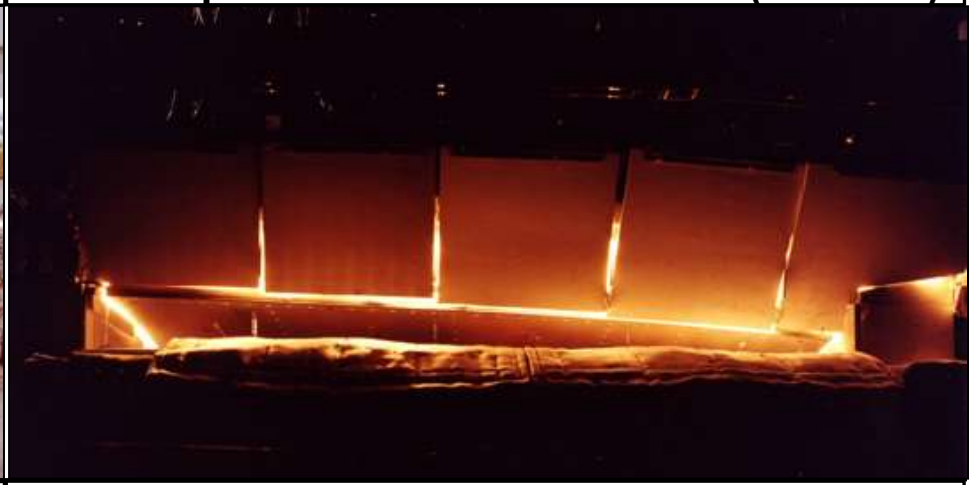
DFRC Thermal Test Facilities

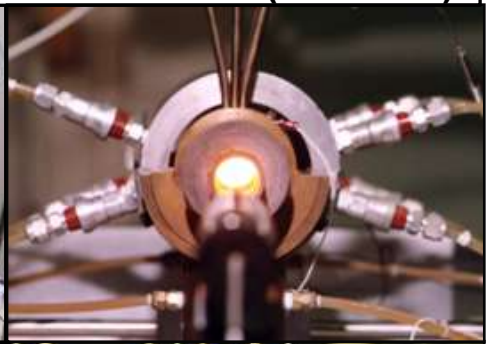
Flight or Full Vehicle Ground Test

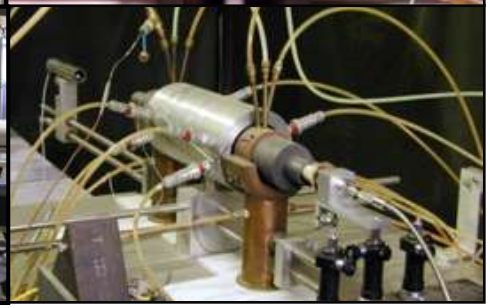
Subcomponent Thermal-Structural (Air/Inert)



Test Article Thermal (Air/Inert)

High-Temperature Instrumentation (Air/Inert)

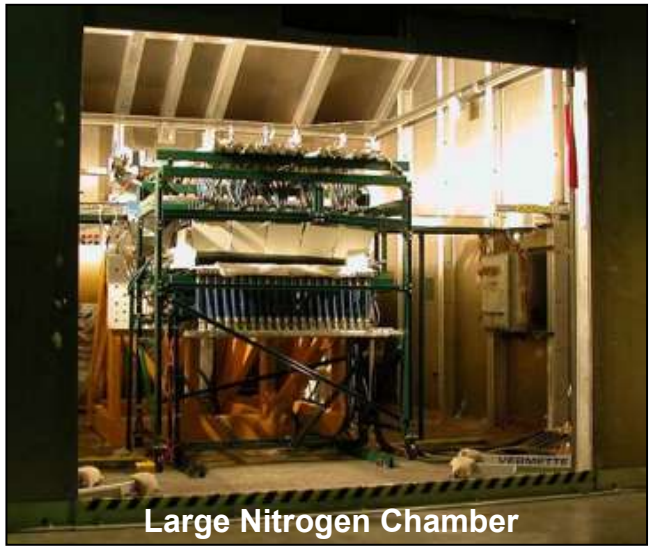




DFRC Thermal Test Facilities

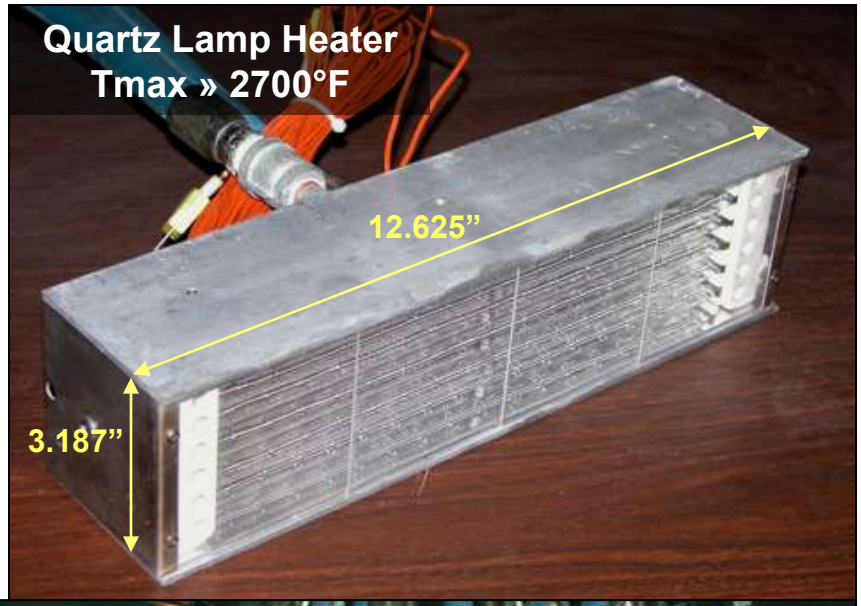
- Flight Test
  - Testbed aircraft (F-15D, F-15B, F-18s, GIII, Ikhana) with flight qualified IR, thermal instrumentation
- Ground Test
  - Flight Loads Laboratory
    - 164’ x 120’ High Bay, 20’ x 23’ x 10’ Nitrogen Chamber
    - Large-scale thermal (subcomponents to full aircraft)
      - Custom contoured banks of quartz lamps (2500°F) or graphite heaters (>3000°F)
      - Simulate supplied trajectory → Temperature, strain, thermal stress distributions, & deflection
    - Large-scale thermal-structural (subcomponents to full aircraft)
      - Simulate supplied trajectory & loads → Temperature, strain, stress, thermal stress distributions, & deflection
      - Hot modal survey → study effect of heating on mode shapes, natural frequencies, and damping
    - High-Temperature Instrumentation
      - Sensor characterization & validation under hypersonic environmental conditions
      - Develop instrumentation (strain, temperature, accelerometers, heat flux) attachment techniques for hypersonic materials exposed to extreme environments
    - NDE (Non-Destructive Evaluation)
      - Develop techniques to inspect hypersonic structures
  - Environmental Laboratory
    - Test Chambers
      - Test aircraft components for proper functioning at altitude pressure & temperature

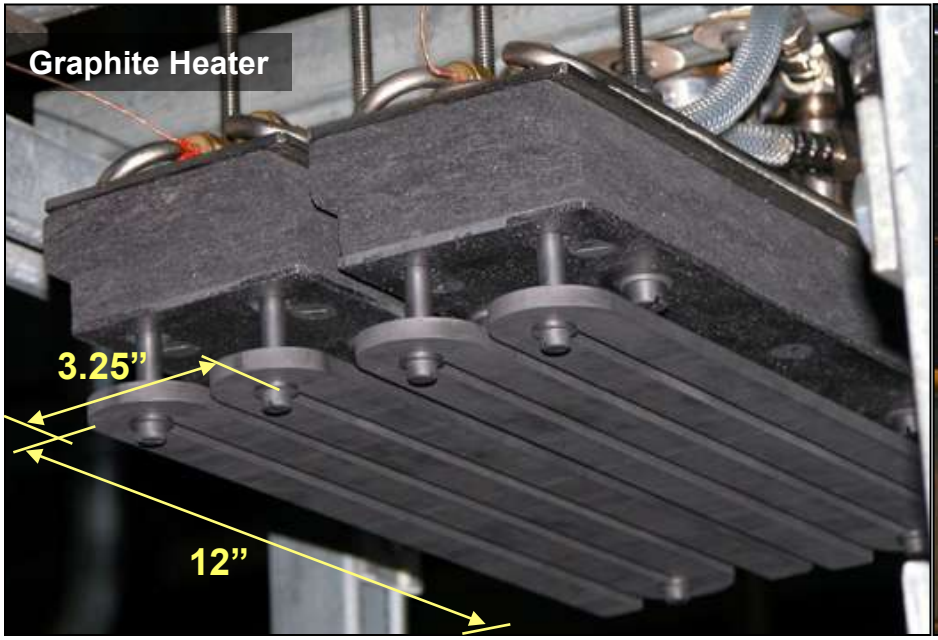
DFRC Thermal Test Facilities

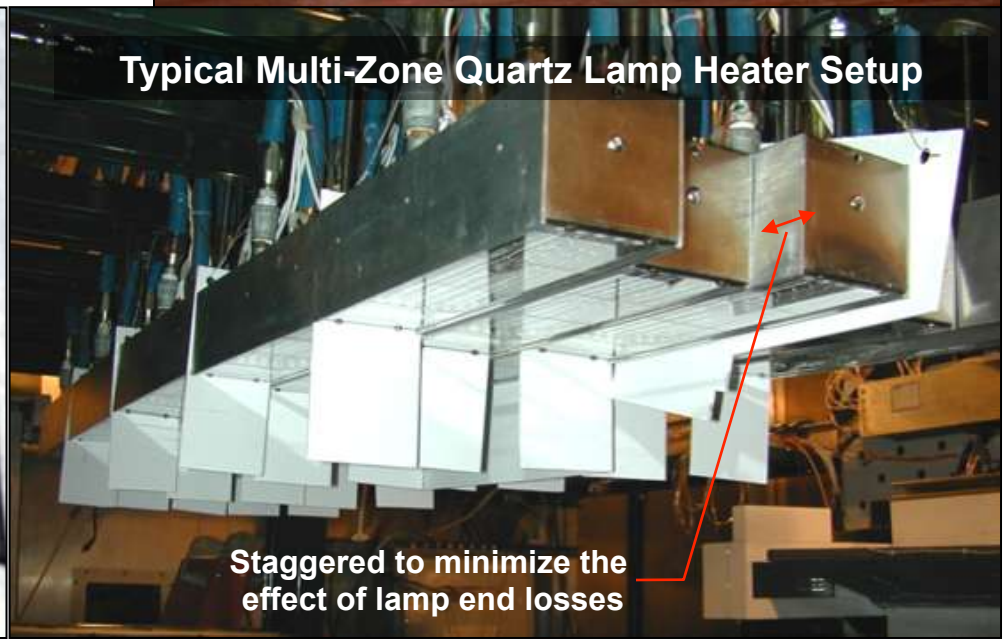


DFRC Thermal Testing Facilities

- **Quartz Lamps**
  - For application <2700°F
  - Polished aluminum reflector
  - Water & gas cooled
  - Quartz window
  - Six 2000W quartz lamps
  - 36KW @ 480V (double rated)
- **Graphite Heaters**
  - For applications >2700°F
  - Test article temperatures beyond 3000°F
  - Requires purged environment



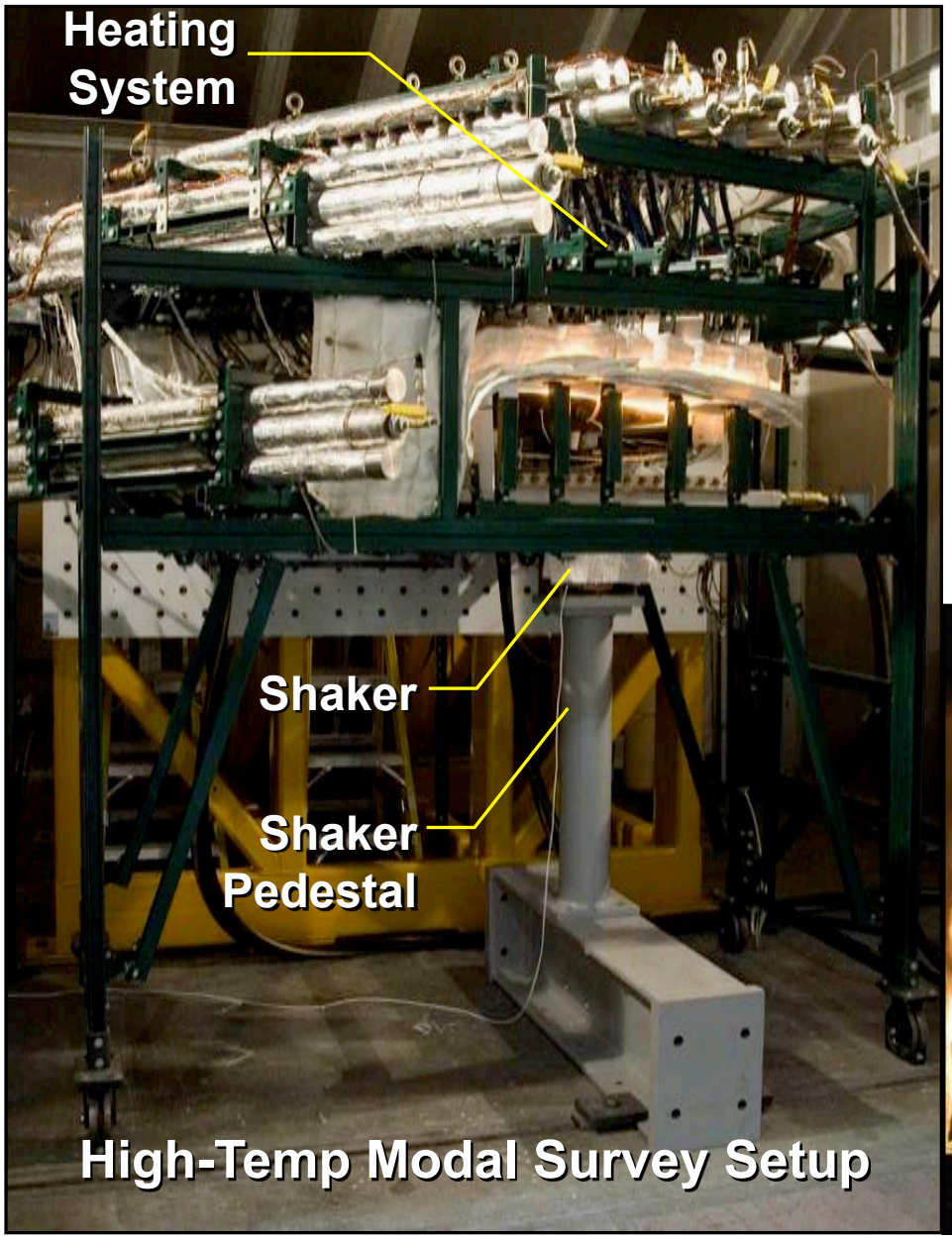




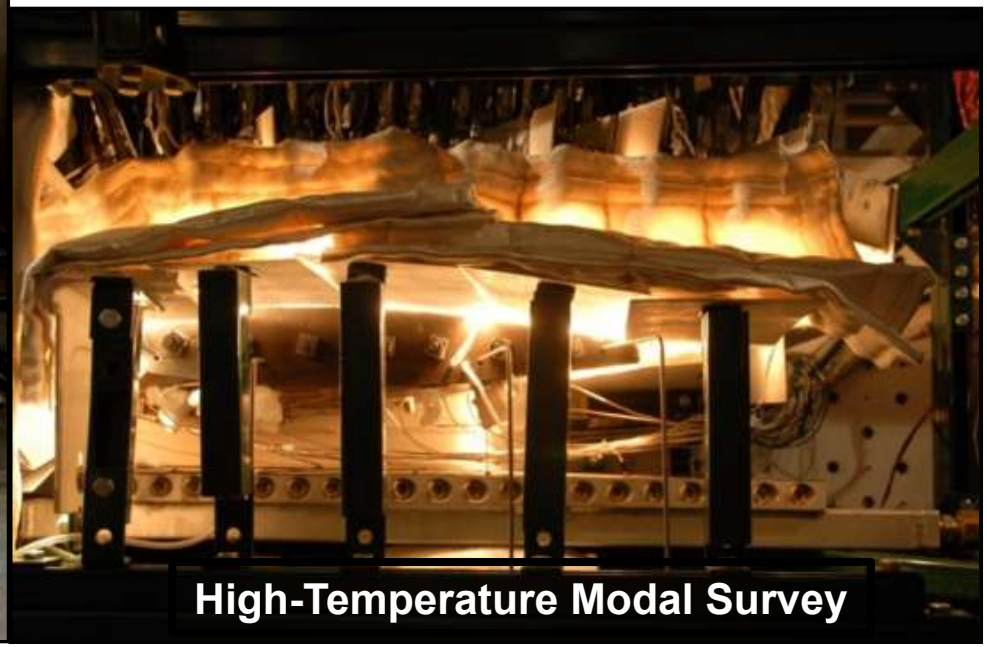
DFRC Thermal Testing

- Flight Test
  - SBLT (Supersonic Boundary Layer Transition)
    - IR investigation of BLT
- Flight & Ground Test
  - SOFIA
    - Thermal stress in imager components, no longer a concern due to analysis & flight test
    - Cavity vent door operation at altitude/temperature, ground testing performed, doors modified
    - Thermal stress in aircraft members due to telescope cavity pre-cool, analyses in-work, ground & flight tests providing data

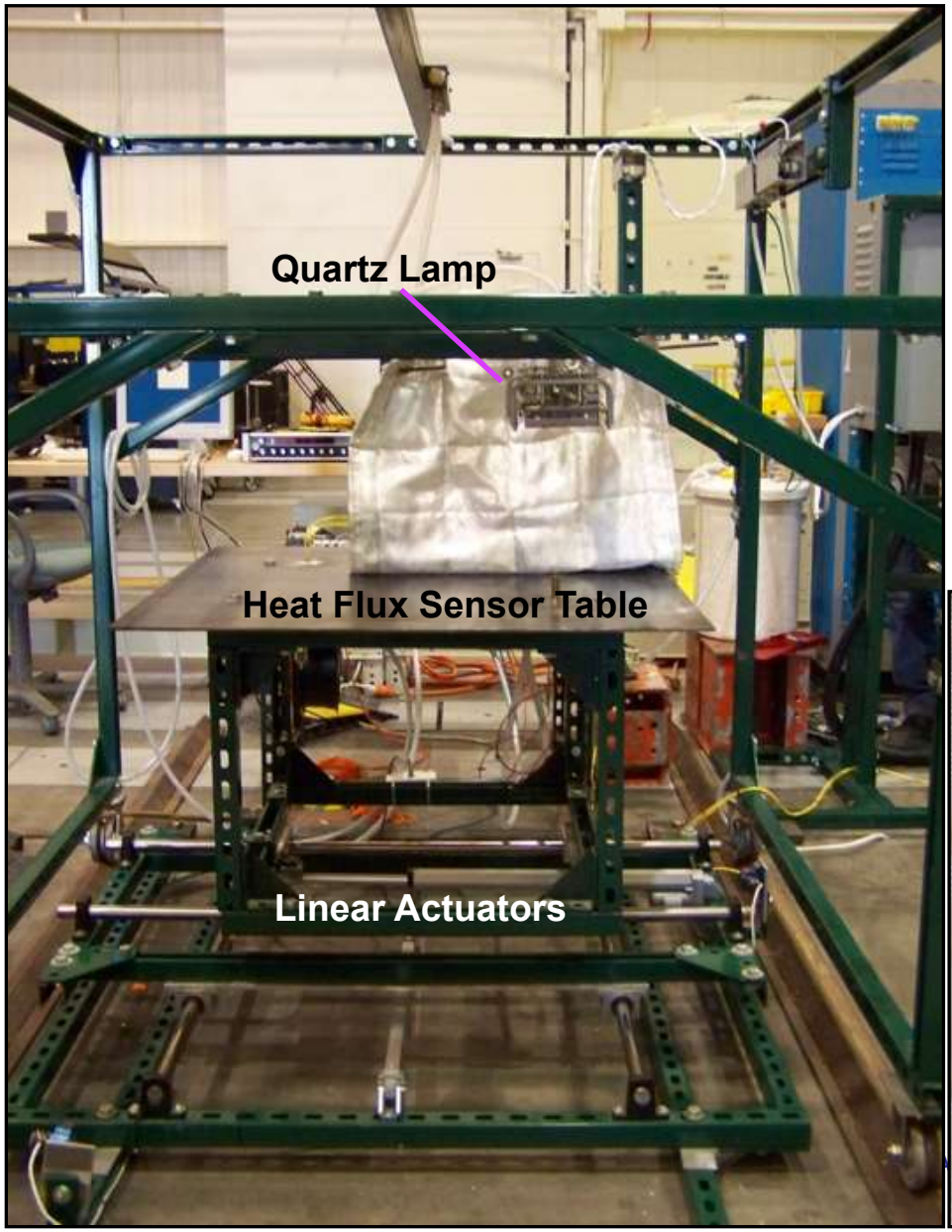
DFRC Thermal Testing



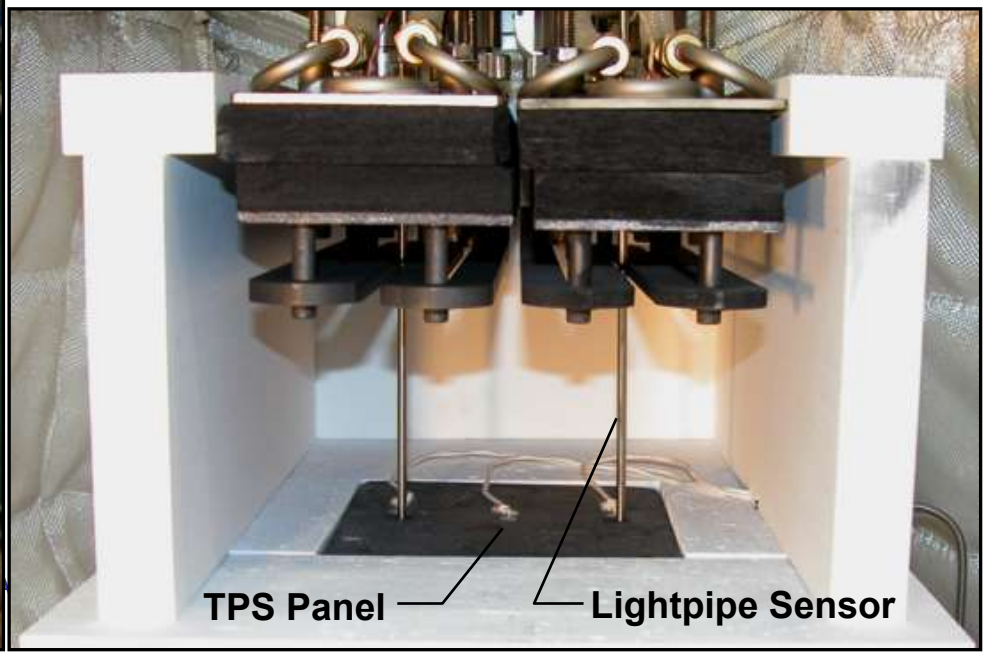
- Ground Test
  - X-37 Ruddervator Thermal-Structural Testing & High-Temperature Modal Survey
    - NASA DFRC / LaRC, Lockheed-Martin, Materials Research & Design, GE CCP
    - Extensive test series investigating structural response of control surface under uncoupled & coupled thermal & structural loading given various profiles
    - High-temperature testing to examine dynamic response temperature variation



DFRC Thermal Testing



- Ground Test (cont'd)
  - SITPS
    - Test effectiveness of integrated structural and thermal load bearing structures
  - Advanced TPS Concepts
    - Test effectiveness of novel TPS concepts
  - Heat Flux Mapping
    - Characterize spatial distribution of lamp & reflector combinations for test/analysis correlation and to improve understanding & configuration of future heater designs



DFRC Thermal Testing

- Ground Test (cont'd)
  - High Temperature Sensor Testing
    - Develop attachment techniques for hot structure materials (C-C, C/SiC)
    - Validate attachment through characterization testing
    - Investigate sensor performance across temperature range for temperature, flux, strain sensors